

HEALTH STUDIES IN THE THREE MILE ISLAND AREA\*

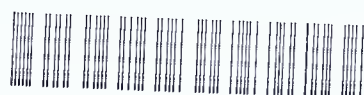
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Dr. Tokuhata was designated by Governor of Pennsylvania to assume overall management of all health research studies related to the TMI nuclear accident of March 28, 1979.



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## HEALTH STUDIES IN THE THREE MILE ISLAND AREA

The Three Mile Island nuclear accident of March 28, 1979 has caused a significant impact upon many facets of human life and social structure not only within Pennsylvania, but also elsewhere in the U. S. and abroad. As a mandate of the State Health Department, it became immediately clear that possible health effects of the accident must be evaluated. During the 10-day period of crisis, it was not possible to ascertain accurate information regarding radioactive emissions from the damaged reactor into the environment. However, the presence of diffuse and growing psychological disturbance in the area was apparent.

Within a short period of days following the accident we were able to conceptualize and develop a comprehensive plan for a variety of epidemiological and other health studies designed to assess the impact of the TMI accident. Specific studies conceived during this critical period reflect mostly the existing epidemiological knowledge regarding biological effect of low level ionizing radiation and of severe emotional stress. As Director of the Bureau of Health Research, I was designated by the Governor of Pennsylvania to coordinate and manage all health-related research activities relative to TMI. At the same time, a special Advisory Panel was commissioned by the Secretary of Health to oversee and guide all TMI-related health studies administered by the State Bureau of Health Research. Some of the studies are still in progress, while others are either completed or in the early stage of development. I am going to present a brief description of each study and some of the findings available at this time.

A. Three Mile Island Census:

One of the first projects initiated shortly after the accident was a special census of all persons living within five miles of TMI. The primary purpose of TMI census was to develop a population profile (TMI Population Registry), which would provide a basic framework for future studies of morbidity and mortality. In addition to usual demographic data, such as age, sex, and race, the census questionnaire included such items as name, address, social security number, marital status, smoking habits, medical history (particularly cancer and thyroid disease), recent pregnancy experience, medical and occupational radiation exposure, and detailed whereabouts during the 10-day crisis, when abnormal radioactive releases were reported.

The TMI Population Registry is comprised of 35,537 persons who were living within five miles of the damaged nuclear reactor at the time of the accident. This cohort includes 254 persons who moved out of the five mile area between the time of the accident and the time of the TMI census in June, 1979. Because of the long latency period for radiation-related health effects to appear, tracing the residents as they moved in subsequent years is essential. We have designed and adopted an automated system of annual tracing and updating the original cohort in the registry.

During the first year after the TMI census was taken a total of 3,526 persons, excluding nursing home patients and dormitory students, were found to have moved. This yielded an annual mobility rate of 11.0 percent. Of those who moved, only 27.3 percent moved beyond the ten mile radius of TMI.

The Pennsylvania Department of Health will continue to monitor the potentially exposed population for 20 years or more in an attempt to detect possible health effects of the TMI nuclear accident. Both cross-sectional and longitudinal comparisons will be made by using comparable control populations, while the effects of various other factors, sociodemographic and environmental, are taken into account. In addition to the existing data sources, such as mortality and natality certificates and hospital discharge statistics, special surveys will be conducted to collect new data. Details of such follow-up studies have not yet been fully developed at this time.

B. Pregnancy Outcome Study:

Both ionizing radiation and severe emotional stress can affect human reproductive process and pregnancy outcome. It is known that the fetus is highly sensitive to such environmental insults. To evaluate possible health impact of the TMI accident, a carefully designed prospective study of pregnancy outcome was initiated in August, 1979. This study covers all pregnant women residing within a ten mile radius of TMI, who gave births during the March 28, 1979-March 27, 1980 period. This study cohort consisting of approximately 4,000 deliveries will be compared with a control cohort of another 4,000 deliveries during a one-year period in the same geographic area immediately following the study cohort. The study cohort will also be compared with similar data collected in the same general area during the immediately preceding four-year period.

Pregnancy outcome measures being investigated are: fetal death (including abortions of 16+ week gestation), hebdomadal (one week) death,

neonatal (28 days) death, prematurity (gestation  $\leq 37$  weeks), immaturity (birth weight  $\leq 2,500$  grams), congenital anomalies, and low Apgar score ( $\leq 7$ ).

While the study design is that of "before-and-after" comparison of cohorts, measures of radiation exposure and psychological stress will be related, on an individual basis, to each of the seven outcome measures described in the preceding paragraph. Two levels of radiation exposure for each pregnant woman being estimated are (a) maximum possible dose and (b) most likely dose. Source materials used for these calculations are taken from various TLD data, meteorological information, and detailed demographic data relative to the individual mobility, including evacuation of the pregnant women during the 10-day period of crisis.

Psychological stress was determined in terms of overt statements of upset/worry as expressed by individual women, as well as stress coping patterns, such as taking tranquilizers and/or sleeping pills.

Since there are many factors that are known or suspected to influence pregnancy outcome, such influences should be and are taken into consideration. These factors include maternal age, race, smoking, drinking, education, occupation, employment, and marital status; maternal medical and obstetric histories, including X-ray exposures; prenatal care, including provider characteristics, medications, instructions and special procedures; prior birth control method; and birth order of the index offspring.

C. Congenital/Neonatal Hypothyroidism:

By Pennsylvania law, all newborn babies in the State must be screened for hypothyroidism since July 1978. This screening consists of two-stage testing; first, low T4 (thyroxin) and high TSH (pituitary thyroid stimulating hormone) on filter paper and second, low T4 and high TSH on serum test. Confirmation of diagnosis is done through thyroid scan. During the initial six-month period (start-up period) testing procedures were not fully standardized and the results were not considered to be complete.

Since it is known that radioactive iodine can cause hypothyroidism, that certain amount of  $I^{131}$  was released from the damaged nuclear reactor during the TMI accident and that  $I^{131}$  can be taken up by pregnant women in the area which, in turn, absorbed by the fetal thyroid gland through placenta, we decided to examine the incidence of congenital/neonatal hypothyroidism among newborn infants. The fetal thyroid gland is much more sensitive to radioactive iodine than is the mother's thyroid gland, i.e., a relatively small dose to the mother can be a relatively large dose to the fetus.

In a normal population, the incidence of congenital hypothyroidism is approximately one in 4,500 to 5,000 infants. There are several different diagnostic classes: namely, genetic type (mostly autosomal recessive, resulting from dyshormonogenesis - i.e., lack of enzyme to synthesize thyroxine); ectopic type (dysgenesis - i.e., incomplete maturation and/or displacement of the thyroid glands); agenesis (without thyroid gland); and other types.



During the March 28, 1979-March 27, 1980 period only one case of congenital hypothyroidism was identified within a ten mile radius among approximately 4,000 infants. This incidence rate is well within a normal range of expectation.

An apparent concentration of seven cases in Lancaster County (mostly beyond the ten mile radius) during 1979 was subjected to a special in-depth analysis. Of the seven cases, one was reported prior to the TMI accident; one with severe multiple CNS anomalies was born three months after the accident, which are unlikely to be associated with TMI; one case was of dysgenesis representing one of discordant twins, thus, non-supportive of the etiology secondary to radiation exposure; and another case of dysgenesis with the thyroid glands being displaced from the normal position.

Having completed detailed diagnostic analysis and epidemiologic assessment of the cases reported in Lancaster County during 1979, we concluded that cases of congenital hypothyroidism were not related to the TMI accident. This conclusion was also consistent with the small dose of radioactive iodine estimated for the TMI area after the accident.

D. Radiation Dose Assessment:

One of the most sensitive and technically difficult tasks was to evaluate the extent to which local residents may have been exposed to radiation from the damaged nuclear facility. While no direct radiation measurements were taken on an individual basis (except for some 700

local residents who subjected themselves to whole-body counts sponsored by NRC during the crisis), available TLD recordings and other source data monitored by various agencies are useful for such a purpose. This study is being conducted through contract by the Department of Radiation Health of the University of Pittsburgh.

Radiation dose assessment is directed towards every person resident within the five mile radius during the nuclear crisis and every pregnant woman resident within the ten mile radius during the same period. From the five mile census data and ten mile pregnancy study data, it is possible to reestablish detailed account of whereabouts during the ten-day period of all individuals, including those who evacuated as well as those who left the area for other reasons.

In addition, detailed daily meteorological data, including wind direction and velocity, as well as plume-dispersion patterns are being incorporated into the combined monitored radiation dose materials from all reliable sources. With the application of computer mapping technology and elaborate sector analysis, it is possible to assign (estimate) a reasonably accurate dosage to an individual in the study areas during the ten-day period. A set of two doses, maximum possible and most likely, are being computed for each individual; the former, without considering physical presence or absence in the area and the latter, with daily mobility data taken into account.

The results of this particular study along with the analysis of background radiation and prior radiation exposure will be useful for a



variety of current and future studies of possible health effects of TMI nuclear accident, particularly from the radiation standpoint.

E. Cytogenetic (Chromosome) Study:

During the early stage of the development of TMI Health Effects Research Program, when the level of radiation emission was not clearly defined, we recommended that a cytogenetic study be carried out to investigate if the incidence of chromosome breakage in human blood cells is unusually elevated among local residents, including those who are employed by the TMI facility and residents living near the facility. Ionizing radiation, if the dose is high enough, is known to be mutagenic and/or teratogenic and can cause physical damage to chromosome structure. Clinical significance of chromosome aberrations of this type is not fully understood, however.

After a lengthy discussion, the TMI Advisory Panel for Health Research Studies recommended to cancel this particular study on the grounds that (a) the amount of radiation emitted in the area was very small, and (b) the cost of the study would be too high to detect a minute difference or increment in chromosome anomalies that may or may not be present.

F. Health Behavioral (Stress) Study:

Shortly after the nuclear accident we recognized that one of the major concerns was the psychological impact upon health among local residents. A number of related questions were asked: (a) How many and what type of people felt emotional distress? (b) How did they cope with the crisis situation? (c) What kind of psychosomatic symptoms

were present? (d) What social and medical/health services were utilized by those who were disturbed by the accident? (e) Is the psychological impact short-lived or long-lasting?

The initial survey was conducted in July, 1979, the second in January, 1980, and the third in October, 1980. These studies indicate that (a) persons who are younger, more educated, married and female were most distressed during the crisis; (b) those who reside within 15 miles of TMI had more stress than did those who reside farther out; (c) the use of sleeping pills and/or tranquilizers to deal with anxiety, as well as certain psychosomatic symptoms increased among certain individuals; (d) the increased level of anxiety experienced following the accident persisted for approximately one year, but declined substantially in October, 1980; and (e) persons with more social support tended to be less distressed than others during the crisis.

G. Mental Health Study:

A study of mental health of TMI workers, mothers with small children and mental health clinic patients was conducted by the Western Psychiatric Research Institute at nine months and one year following the TMI accident. The mental health assessments include both clinical and subclinical measures.

TMI mothers had an excess risk of experiencing clinical episodes of anxiety and depression during the year after the accident. They also reported more symptoms of anxiety and depression at subclinical levels.

TMI workers were essentially similar to control workers (Beaver Valley Nuclear Plants) with respect to mental health indicators under study both at the clinical and subclinical levels.

Mental health clinic patients expressed similar level of symptoms or anxiety at both TMI area and Beaver Valley area selected as control.

H. Infant Mortality Study:

Subsequent to the March 1979 nuclear accident, we initiated a comprehensive evaluation of the existing vital statistics data in order to determine if the TMI accident has had any measurable influence upon infant mortality in the vicinity of the plant.

Within the ten mile radius of the damaged nuclear reactor, we found no evidence that the rise or fall of the infant mortality was caused by the accident.

The infant mortality rate was not significantly different between the ten mile area and the State of Pennsylvania for any of the three years, 1977, 1978, and 1979. The rate within the ten mile radius was already considerably high during the first quarter of 1979. The rate remained at the same level during the second quarter of 1979 immediately following the accident, but declined substantially during the following two quarters. If the TMI accident had a significant influence, the infant mortality rate would have increased steadily throughout the last two quarters because of different sensitivity of the fetus to radiation at different gestation periods when exposed.

# I. Other Studies:

Several other studies have been developed or conducted. These are (a) Health Economics Study, which was designed to assess immediate and short-term excess health costs (direct and indirect) and expenditures due to TMI accident; (b) Cardiac Mortality Study, which was designed to evaluate possible psychological impact upon those local residents who had cardiac conditions; (c) Family Unity Study, which was designed to examine how, if any, the nuclear accident may have affected family unity or bond; and (d) Mobility Study, through which the extent of mobility (moving) can be determined that may be attributable to the nuclear accident.

## Summary:

The TMI nuclear accident has presented social scientists and biomedical investigators a unique opportunity to evaluate its impact upon local population. Probably the most important concern is that of safety and health effects of the accident.

From the currently available epidemiological knowledge, no significant physical health effects are expected from the low level radiation released from the damaged TMI facility. However, some substantial psychological impacts are apparent. In addition, because of high sensitivity of the fetus to ionizing radiation and severe stress, timely evaluation of pregnancy outcome should be pursued. Based on the already established TMI Population Registry, there should be a continuous and long-term epidemiologic surveillance of the exposed population. Such endeavor will make it possible to determine and document, if there is any measurable health impact in humans from the low level of radiation that has not yet been fully studied in humans.



